Integrating Anthropometry and Computer Aided Design to Manufacture and Evaluate Protective Military Handwear

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Content

- Use of anthropometry to design handwear with increased fit
- Generation of CAD models using hand anthropometry
- Use of CAD models to produce mould tool to manufacture handwear – Dip moulding former
- User trials to test finger dexterity & tactile perception

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Background

- The EPRG contributes towards a better understanding towards the complex interaction between the extremities and an object during a task performance
- Previous research investigating the affect of protective handwear on task performance – Fit is critical
- Improve this performance by improving fit
- Use hand anthropometry of intended end user to design gloves with enhanced fit

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Anthropometry

- Anthropometry survey of undergraduate students taken every year
- Hand data from this database were processed into a series of 6 sizes (6 to 11)
- Sizes generated using knowledge of glove design

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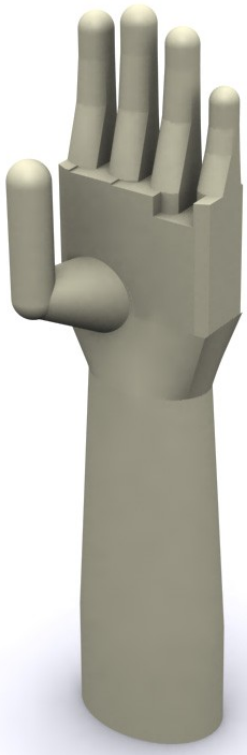
CAD Model Generation

- Geometric shapes generated to represent different parts of the hand
- Initial CAD model required additional data to improve accuracy
- Additional measurements taken and some data re-processed
- Size data updated and integrated into CAD model



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Dip Moulding

- Non-woven manufacturing technique using a former to produce the shape of the glove
- Former requires smooth, uniform surface
- Creates glove that exactly matches the size and shape of former
- The initial CAD model was too geometric and had insufficient detail

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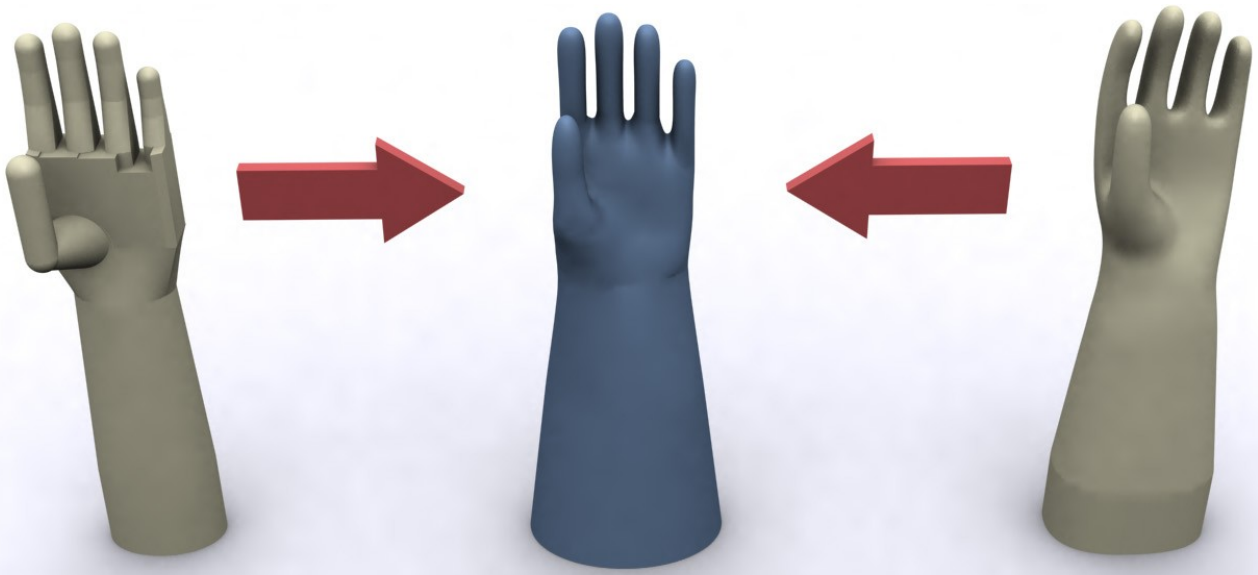
Development

- Detail from current formers integrated to develop CAD model



- Rapid prototyping methods used to create prototype glove former from CAD model

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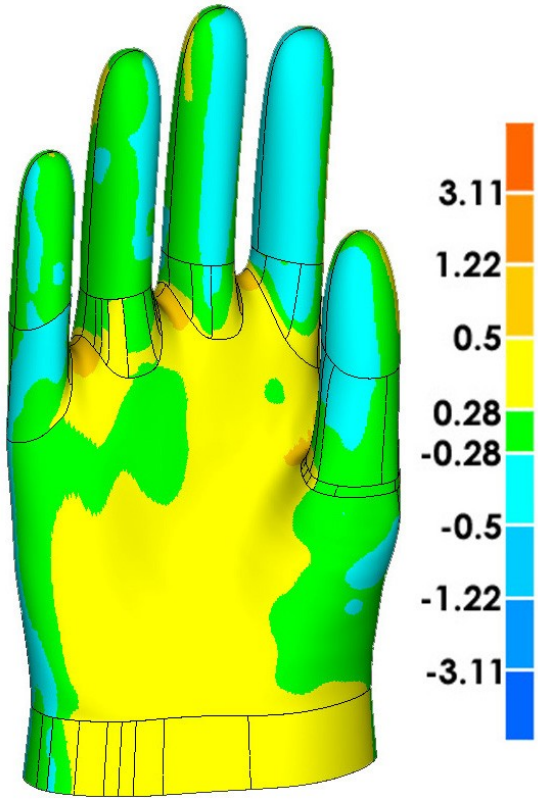
Accuracy

- Accuracy of prototype former assessed by comparing it to CAD model
- 3D scanning of former allowed comparison to be made using Computer Aided Inspection software
- Tolerances calculated and deemed to be acceptable



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Glove Manufacture

- Gloves produced from standard and prototype former with the help from a glove manufacturer – Comasec Yate Ltd
- Size 9 produced to ensure a large sample of subjects for user trials
- Both sets of gloves
  - were made from the same material
  - had the same thickness
  - used same manufacturing process
  - only varied in size and shape

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Glove Evaluation

- 8 male subjects used to evaluate prototype gloves, selected by matching to size data
- Compared against bare hands & standard glove
- Series of dexterity tests
  - Peg Board Test
  - Nut & Bolt Assembly
  - Pin Pick Up Test *(BS EN 420)*
  - Keyboard Typing Test
  - Grip & Pinch Strength

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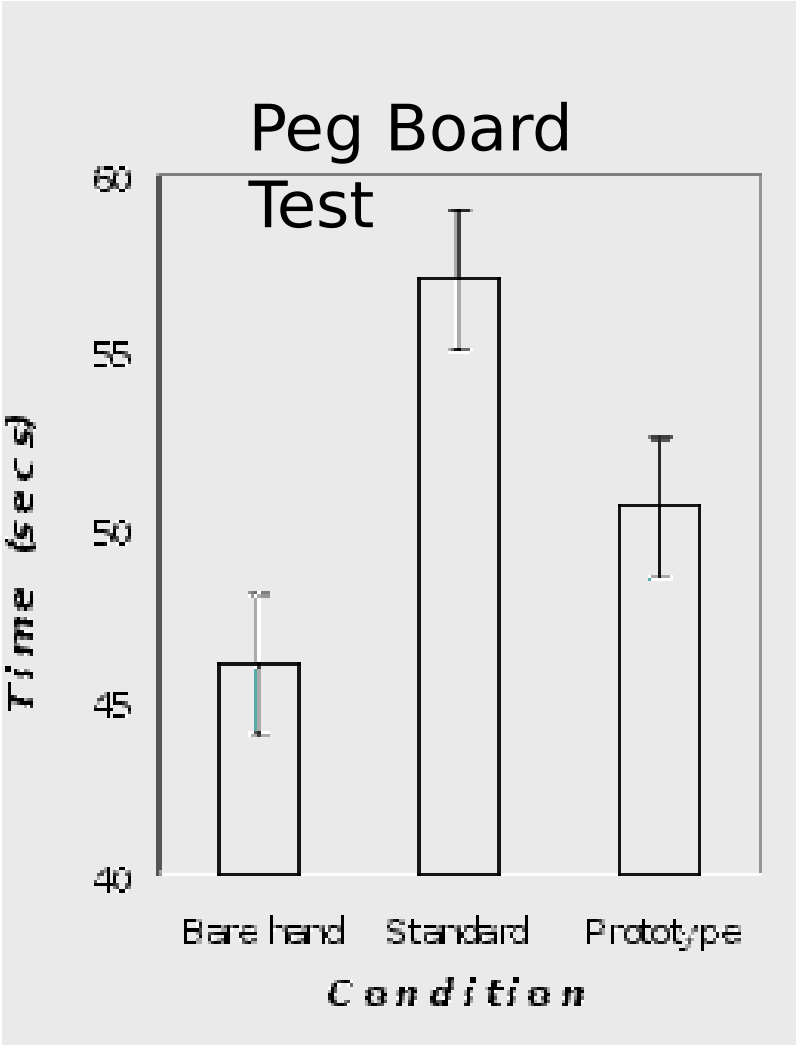
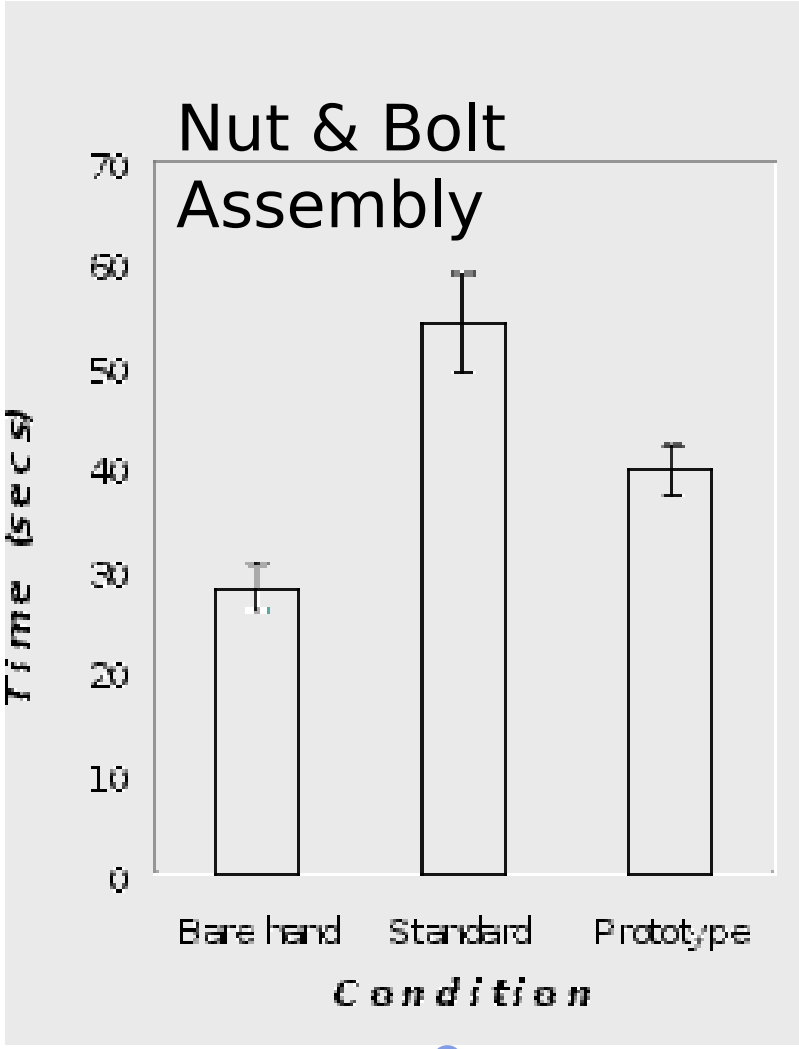
Results





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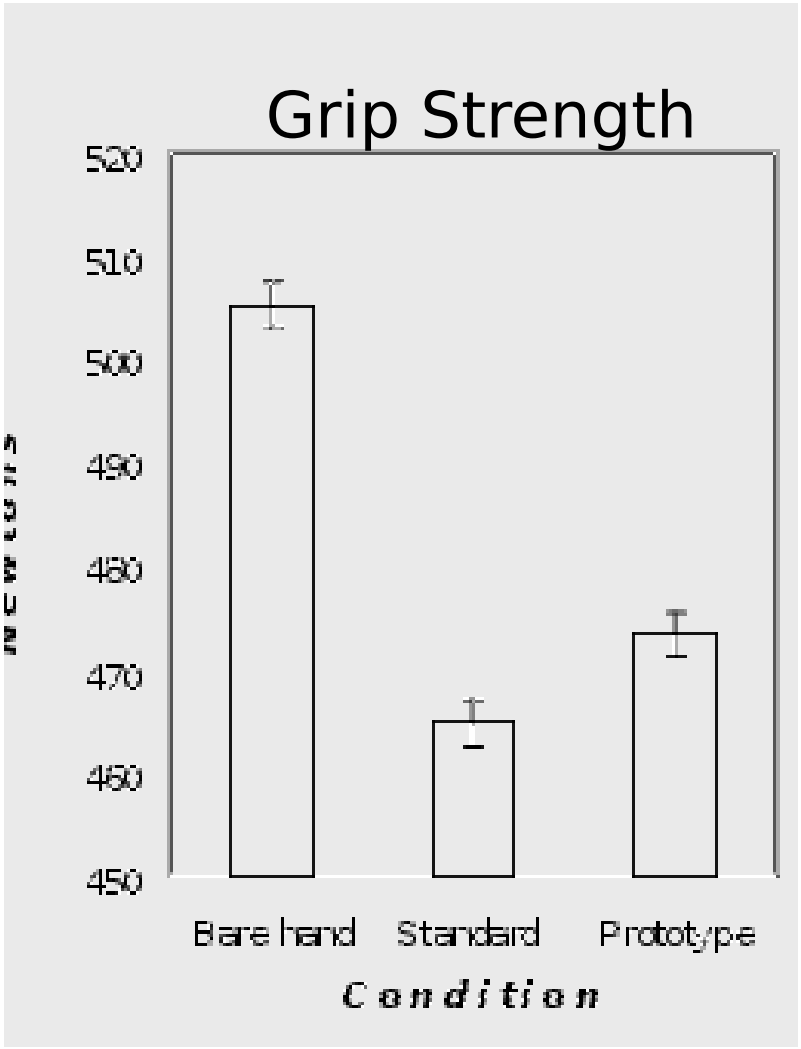

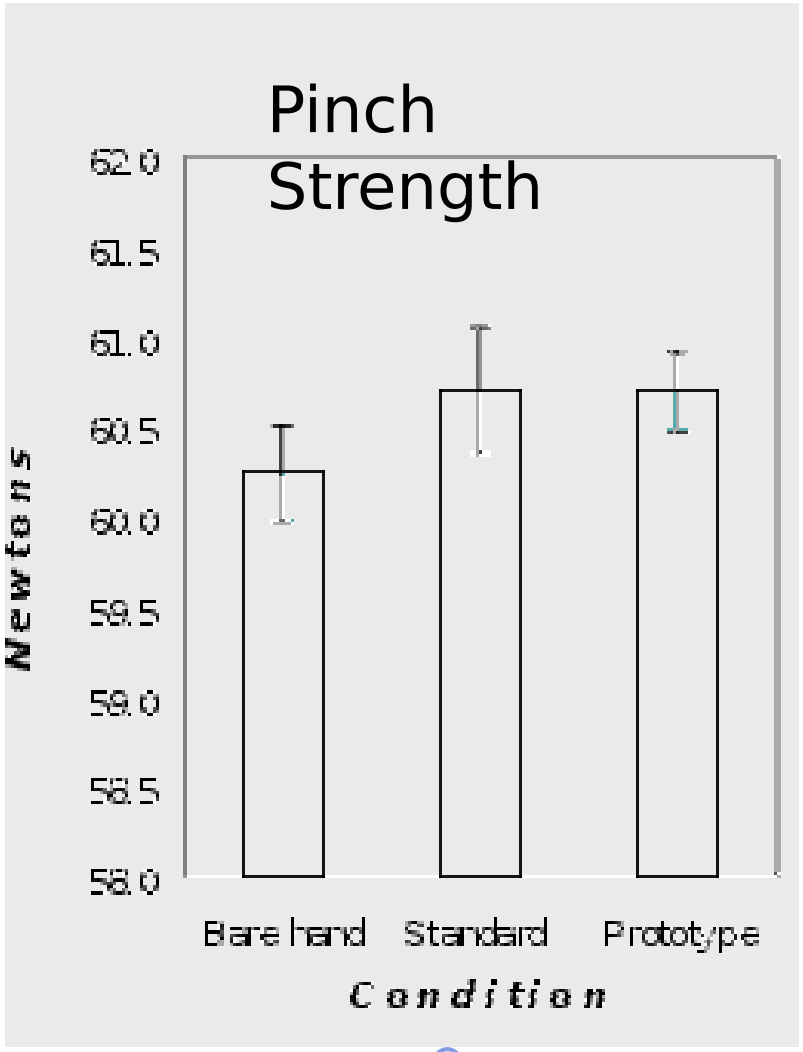

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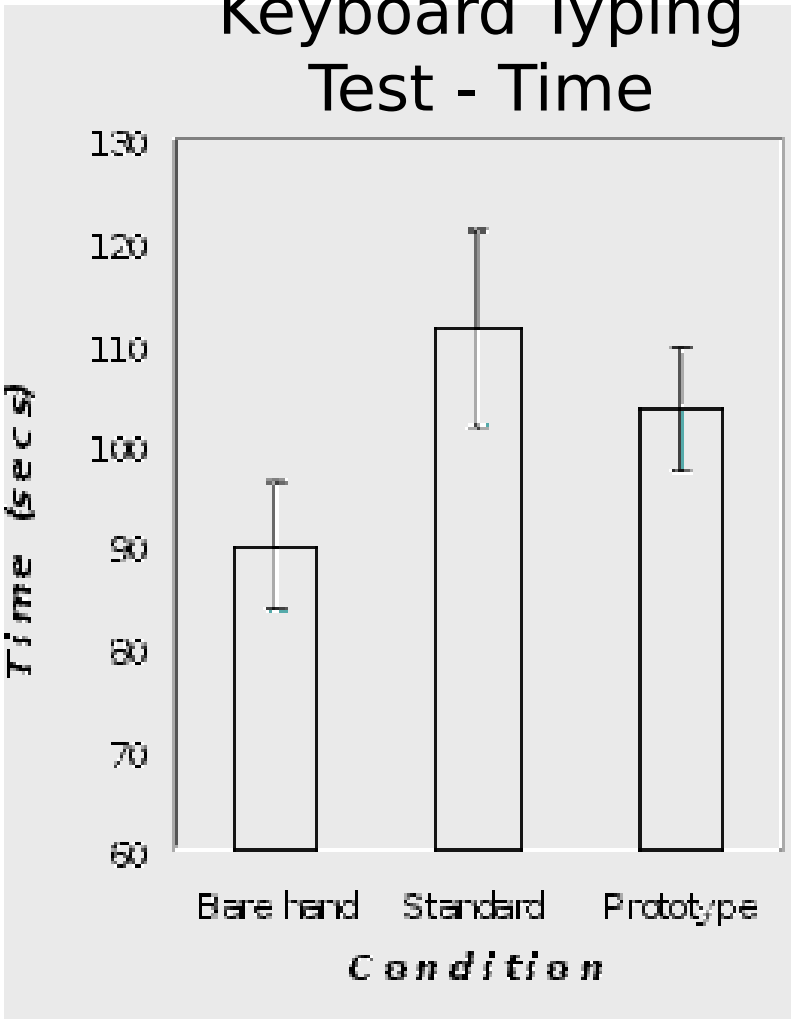

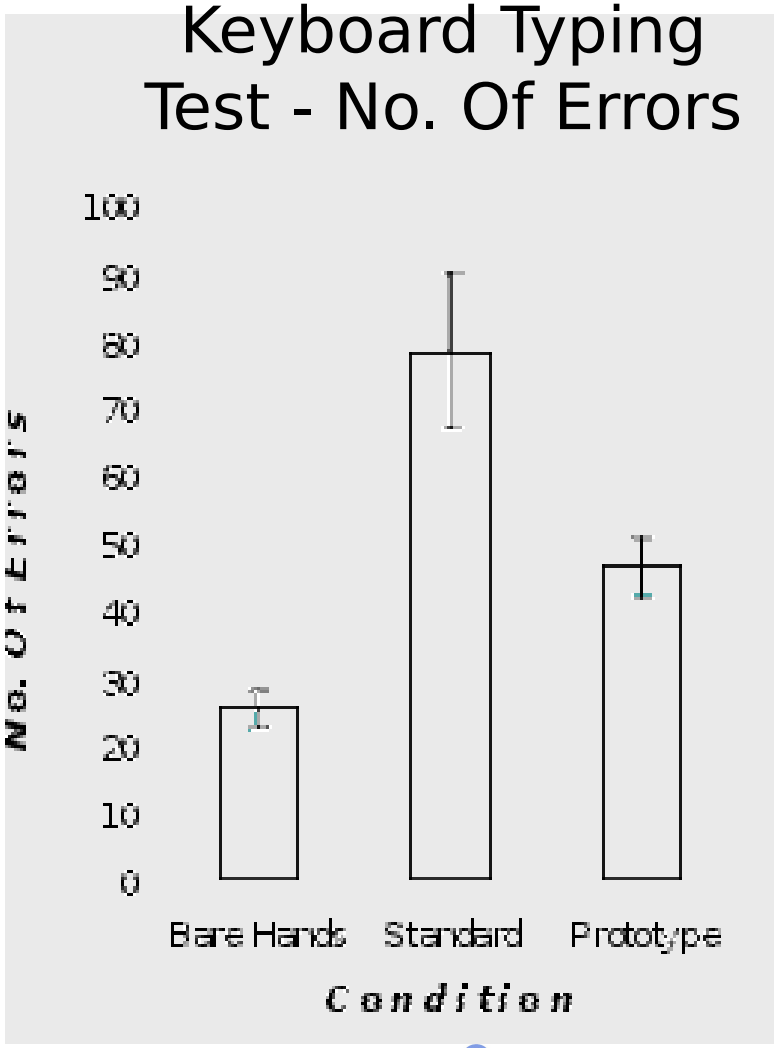

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Results - Summary

- In all tests, subjects had increased performance wearing the prototype gloves compared to standard gloves
- Wearing the prototype gloves subjects showed:
  - increased dexterity and tactile perception
  - an enhanced ability to manipulate small objects quicker and easier
  - an increased grip strength
- Due to an enhanced fit of the glove

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Practical Applications

- Dip moulding formers currently used for glove manufacture – NBC protective handwear
- Formers can be redesigned to provide enhanced fit
- Non-woven manufacturing methods employed for other types of protective handwear
- Initial CAD model being developed as a Size Gauge for quality assurance and evaluation of handwear

Conclusions

- Using anthropometry in the design process improves fit of handwear
- Design of CAD model allows anthropometry from any population to be used
- Important to consider use of anthropometry prior to and during its collection – more anthropometry gives more accuracy
- Methods can be used to design various types of clothing & body worn products for different parts of the body; e.g. foot, head, back

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